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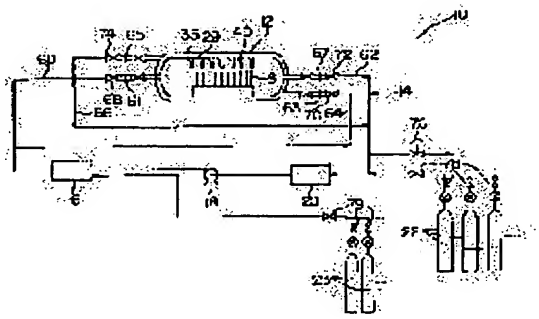
(54) HEAT TREATING APPARATUS

(57)Abstract:
PURPOSE: To provide a heat treating apparatus, wherein the formation of an oxide film on a wafer is prevented, and the temperature distribution in a core tube is made uniform with the flow rate of gas flowing in the core tube being suppressed to the low value.
CONSTITUTION: A heat treating apparatus 10 has a core tube part 12, a circulating line 14, an electric-furnace gas heater, a fan device 18, a water cooling type gas cooler 20 and gas introducing devices 22 and 23. The core tube part 12 comprises an inner tube 29 and an outer tube 35. The respective part is constituted of the main body having the opening part and the cap part, which is coupled with the opening part. The main bodies and the cap parts of the inner and outer tubes have the introducing pipes having the closing valves or exhuast pipes, respectively, and linked to the gas introducing system and the gas exhausting system of the circulating path having the closing valves. Many obstruction plates 40 are arranged on the inner wall of the inner tube separately in the longitudinal direction and the circumferential direction in the zig-zag pattern. After a wafer is contained, the gas is replaced with inert gas Linking with the core tube path is performed, and the inactive gas is circulated. The inactive gas is heated, and the wafer is heat-treated. The inactive gas is cooled, and the gas is changed into O2, and H2. Thus an oxidizing apparatus can be obtained.



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CLAIMS

[Claim(s)]
[Claim 1] In the thermal treatment equipment which heat-treats the processed material which was equipped with the work tube which has opening which can be opened and closed freely, and carried out carrying-in appearance through opening within a reactor core A gas inlet with a closing motion valve and a gas exhaust port with a closing motion valve are prepared in a work tube. Furthermore, the circulation duct is equipped with the 1st end connection with a closing motion valve and the 2nd end connection connectable with the gas inlet and gas exhaust port of a work tube, respectively free [dissociation], and it was made to circulate through a gas via a work tube, The thermal treatment equipment characterized by having the gas heating apparatus, the gas cooling equipment, and the blower which were formed in the circulation duct.
[Claim 2] It consists of double pipes with which said work tube consists of an inner tube which arranges a processed material, and an outer tube which surrounds an inner tube from the outside. Each has a gas inlet with a closing motion valve, and a gas exhaust port with a closing motion valve. And the thermal treatment equipment according to claim 1 characterized by establishing the circulation duct in each of an inner tube and an outer tube so that the flow direction of the gas which flows the annular passage between the gaseous flow directions, outer tubes, and inner tubes which flow the inside of an inner tube may become reverse.
[Claim 3] The thermal treatment equipment according to claim 1 or 2 characterized by forming the baffle which changes the flow of the gas within a reactor core into a turbulent flow condition in the tubing wall of the work tube which arranges a processed material.

[Translation done.]

* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] About a thermal treatment equipment, further, this invention heats the wafer for semiconductor devices in a detail, and relates to the thermal treatment equipment for carrying out thermal diffusion of the impurity, or forming an oxide film on a wafer.
[0002]
[Description of the Prior Art] In the production process of a semiconductor device, a thermal treatment equipment heats a wafer, and it is used in order to carry out thermal diffusion of the impurity, to perform annealing or to form an oxide film. While has been arranged in the location of B and the conventional thermal treatment equipment 80 is equipped with the work tube 84 which has opening with a shutter 82 at the edge, and the heater 86 formed in the periphery of a work tube 84, as shown in drawing 5 . N2 Gas is N2 prepared in the other-end section of a work tube. It is introduced from a gas inlet 88 and discharged from the exhaust port of a near [a shutter 82].
[0003] When carrying out thermal diffusion processing of the wafer S, Wafer S is arranged on the wafer boat 90, and the location of A is made to stand by. On the other hand, a work tube 84 is heated at a heater 86, and predetermined temperature is reached, and a shutter 82 is opened wide, the wafer boat 90 is fed in a work tube 84 with the boat loader 92 via opening, and it arranges in the predetermined location C by stages. After carrying out predetermined time progress, the wafer boat 90 is picked out from a work tube 84 in a reverse procedure, and it returns to the position in readiness of A.
[0004]
[Problem(s) to be Solved by the Invention] However, the conventional thermal treatment equipment mentioned above has a problem which is described below. First, the 1st problem is that an oxide film is formed on the surface of a wafer. It is hot N2 at the time of the carrying-in appearance of a wafer boat. Since gas is emitted in large quantities into atmospheric air from the work tube via opening, it is N2 of the open air and an elevated temperature. Near opening where gas is mixed has been the ambient atmosphere in which hot oxygen exists. Therefore, when Wafer S passes opening in connection with the carrying-in appearance of a wafer boat, a wafer oxidizes by hot oxygen and an oxide film is formed in a front face. In the making process of a semiconductor device, after a heat treatment process, although the process which removes this oxide film is carried out, before being removed, the phenomenon an impurity carries out [a phenomenon] anomalous diffusion within a semi-conductor arises by the oxygen which constitutes an oxide film. This phenomenon affects the property of a semiconductor device, is on quality control of a semiconductor device, and poses a problem, so that a semiconductor device is detailed and high-density.

[0005] As the 2nd problem, the conventional thermal treatment equipment is saying that it is necessary to pass a lot of inert gas (for it to be mainly N2 gas) within a reactor core, in order to make the temperature distribution within a reactor core into homogeneity. This is the cause which increases the costs of a heat treatment process.
[0006] It is offering the thermal treatment equipment which equalized the temperature distribution within a reactor core, being offering the thermal treatment equipment improved so that the oxide film which is not a request might not be formed [in / in the 1st / a heat treatment process] by the purpose of this invention on a wafer in view of an above-mentioned problem, and pressing down low the flow rate of the gas which flows within a reactor core to the 2nd.
[0007]
[Means for Solving the Problem] In order to attain the 1st above-mentioned purpose, the thermal treatment equipment concerning this invention In the thermal treatment equipment which heat-treats the processed material which was equipped with the work tube which has opening which can be opened and closed freely, and carried out carrying-in appearance through opening within a reactor core A gas inlet with a closing motion valve and a gas exhaust port with a closing motion valve are prepared in a work tube. Furthermore, the circulation duct is equipped with the 1st end connection with a closing motion valve and the 2nd end connection connectable with the gas inlet and gas exhaust port of a work tube, respectively free [dissociation], and it was made to circulate through a gas via a work tube, It is characterized by having the gas heating apparatus, the gas cooling equipment, and the blower which were formed in the circulation duct.
[0008] The work tube used by this invention may be a work tube of the same quality of the material made from a quartz as the conventional work tube, for example, a product, and a horizontal type or a vertical mold is sufficient as it. Gas heating apparatus has the gas heating apparatus of the electric furnace format which is a known means by which the gas was heated, for example, prepared the duct where a gas flows in the electric furnace by heating a sink and a heating tube for a gas from the outside of tubing within heating. Gas cooling equipment is known gas cooling equipment of air cooling or a water cooling type. Moreover, the known fan for elevated-temperature gas can be used for a blower.
[0009] The inner tube with which, as for the desirable embodiment of this invention, a work tube arranges a processed material, Consist of double pipes which consist of an outer tube which surrounds an inner tube from the outside, and each has a gas inlet with a closing motion valve, and a gas exhaust port with a closing motion valve. And it is characterized by establishing the circulation duct in each of an inner tube and an outer tube so that the flow direction of the gas which flows the annular passage between the gaseous flow directions, outer tubes, and inner tubes which flow the inside of an inner tube may become reverse.
[0010] Moreover, in order to attain the 2nd purpose, the desirable embodiment concerning this invention is characterized by forming the baffle which changes the flow of the gas within a reactor core into a turbulent flow condition in the tubing wall of the work tube which arranges a processed material. A baffle is the obstruction of the flow which is equipped with the field which intersects gaseous

flow, says hydrodynamically, disturbs gaseous flow, and is changed into a turbulent flow condition here, and it has the function which makes the gaseous rate of flow homogeneity in each location of the cross section of the passage which intersects perpendicularly with a gas flow direction. As long as the configuration of a baffle achieves the purpose, there is especially no constraint.

[0011]

[Function] In invention of claim 1, the circulation duct which permuted air by the work tube which held the wafer boat which carried the wafer in the interior, and permuted air with inert gas, and was isolated from the exterior with inert gas similarly, and was isolated from the exterior is connected, and inert gas is circulated with the blower via a work tube along a circulation duct. Subsequently, the circulating inert gas is heated with gas heating apparatus, and the wafer within a reactor core is heat-treated with hot inert gas. The inert gas which suspends and circulates through gas heating apparatus is cooled with gas cooling equipment after termination of a heat treatment process. A work tube is separated from a circulation duct after cooling termination, and the wafer boat which opened opening wide further and was cooled is taken out. The closing motion valve of a gas inlet and a gas exhaust port is stopped introducing inert gas from a gas inlet and discharging inert gas from a gas exhaust port, in order for inert gas to permute the section of a reactor core and to isolate from the open air. The closing motion valve of the 1st end connection and the 2nd end connection is stopped introducing and discharging inert gas to each gas passage of the gas heating apparatus connected to the circulation duct and the circulation duct, gas cooling equipment, and a blower, in order similarly for inert gas to permute the interior of a circulation duct and to isolate from the open air.

[0012] In invention of claim 2, since the flow direction of the gas which a work tube consists of double pipes, and flows the annular section between the flow direction of the gas in an inner tube, and an inner tube and an outer tube is reverse, the temperature distribution in an inner tube can be made into homogeneity at the time of work tube heating. Moreover, since the outer tube has enclosed the perimeter of an inner tube, there is no possibility that the foreign matter which metal etc. does not have may invade in an inner tube from the exterior.

[0013] By invention of claim 3, since gaseous flow becomes a turbulent flow and the rate of flow in each location of the cross section of a flow direction is equalized by forming a baffle in the work tube with which the wafer is held, the temperature distribution within a reactor core become fixed by the small flow rate.

[0014]

[Example] Hereafter, with reference to an accompanying drawing, this invention is explained more to a detail based on an example. The typical sectional view in which the general flowsheet which shows the configuration of one example of the thermal treatment equipment which drawing 1 requires for this invention, and drawing 2 show the configuration of a work tube, and drawing 3 are the sectional views of view I-I of drawing 2 . The thermal treatment equipment 10 of this example is the reactor core tube part 12, the circulation duct 14, the electric furnace type gas heating apparatus 16, fan equipment 18, the water cooling type gas cooling machine 20, and N2 and O2, as shown in drawing 1 . The gas installation

equipments 22, such as gas, and H2 It has the gas installation equipments 23, such as gas.

[0015] The body 26 of an inner tube with which the reactor core tube part 12 has opening 24 at one edge as shown in drawing 2 , The inner tube 29 which consists of an inner-tube covering device 28 which fits into the periphery of opening 24 and stops opening 24, The periphery of the body 26 of an inner tube is surrounded, and it consists of outer tubes 35 which consist of the body 26 of an inner tube, an outer-tube body 32 which has opening 30 at the edge of the same side, and an outer-tube covering device 34 which fits into the periphery of the opening 30 of the outer-tube body 32, and stops opening 30.

[0016] The gas installation tubing 44 which has the gas exhaust pipe 38 and the closing motion valve 42 which have the closing motion valve 36, respectively is formed in the opening 24 of the body 26 of an inner tube, the edge of the opposite side, and the inner-tube covering device 34, and a gas flows the inside of an inner tube 29 in the direction X of an arrow head. Moreover, the gas exhaust pipe 52 which has the gas installation tubing 48 and the closing motion valve 50 which have the closing motion valve 46, respectively is formed in the opening 30 of the outer-tube body 32, the edge of the opposite side, and the outer-tube covering device 34. The gas exhaust pipe 36 of the body 26 of an inner tube and the gas installation tubing 44 of the inner-tube covering device 26 penetrated the edge wall and the outer-tube covering device 34 of the outer-tube body 32, respectively, and have projected them to the method of outside. After tubing may be joined to the edge wall or the covering device wall in one and the penetration section makes the through tube of an edge wall or a covering device penetrate tubing, it may be closed with encapsulant. Of the above configuration, the annular gas passage 54 is formed between an inner tube 29 and an outer tube 35, and a gas flows the inside of the annular passage 54 in the direction of an arrow head Y.

[0017] Many baffles 40 are formed in the internal surface of the body 26 of an inner tube over the whole surface. As are shown in drawing 2 , and it is the block which sees to the longitudinal direction of the body 26 of an inner tube, and has the cross-section configuration of an abbreviation trapezoid and is shown in drawing 3 , it goes over a baffle 40 all over the wall of the body 26 of an inner tube, it is isolated to the hoop direction and longitudinal direction of the body 26 of an inner tube, moreover, is seen to a longitudinal direction, and is arranged alternately (although the broken line of drawing 3 has been alternately arranged behind the baffle 40 displayed as the continuous line, it is instantiation). As each baffle 40 is shown in drawing 2 , the flat surface where the longitudinal direction of the body 26 of an inner tube and the field 56 of the downstream of gaseous flow cross at right angles is accomplished, a curved surface which the field 58 of the upstream isolates from the field 56 of the downstream as it goes to the wall surface of the body 26 of an inner tube is accomplished, and height has a dimension which does not collide with the wafer laid on the wafer boat from the wall surface of the body 26 of an inner tube.

[0018] As you may form in one with the body 26 of an inner tube and it is shown in drawing 4 (a) and (b), as long as it forms separately the baffle tubing 59 which formed the block of a baffle 40 in the shell 57 of an outer diameter almost equal to

the bore of the body 26 of an inner tube, it inserts it into the body 26 of an inner tube if needed and it becomes unnecessary, you may make it pull out a baffle 40. Drawing 4 (a) is the sectional view of the longitudinal direction of the baffle tubing 59, and drawing 4 (b) is the cross-sectional view of view II-II of drawing 4 (a).

[0019] The circulation duct 14 consists of two lines of the outer-tube system of the inner-tube system of the gas installation system 60 connected to an inner tube 29, and the gas excretory system 62, the gas installation system 64 connected to an outer tube 35, and the gas excretory system 66, as shown in drawing 1 . The gas installation systems 60 and 64 and the gas excretory systems 62 and 66 were connected with each gas installation tubing and the gas exhaust pipe of the reactor core tube part 12 by the connection sections 61, 63, 65, and 67, and are equipped with its its closing motion valves 68, 70, 72, and 74 near the connection section. The connection method of the connection sections 61, 63, 65, and 67 is the so-called quick coupling type or a fitting type, and can be connected now simple and quickly. Furthermore, N2 in a circulation duct In order to adjust the pressure of gas, the pressure regulating valve 76 is formed in the circulation duct 14.

[0020] The electric furnace type gas heating apparatus 16 is known gas heating apparatus with which a gas consists of a heating tube which flows the interior, and an electric furnace which heats a heating tube. A by-pass line may be established in the surroundings of the gas heating apparatus 16, and the gas heating apparatus 16 may be made to bypass if needed in the case of the cooling process mentioned later. Moreover, fan equipment 18 is the known blower fan for elevated-temperature gas which can ventilate elevated-temperature gas. The water cooling type gas cooling machine 20 is a water cooling type condensator of a known double pipe mold, and passes the gas which cools cooling water to an inner tube in the annular space of a sink, an inner tube, and an outer tube. The gas cooling machine 20 may be made to bypass if needed in the case of the heating process which established the by-pass line in the surroundings of the gas cooling machine 20, and mentioned it above. N2 Gas installation equipment 22 is N2. It is equipment equipped with the chemical cylinder and the gas pressure regulator valve, and connects with the circulation duct 14 through the closing motion valve 78.

[0021] Below, how to use and heat-treat this example equipment is explained. First, as the reactor core tube part 12 is removed from a thermal treatment equipment 10 and it is shown in drawing 2 , after introducing the wafer boat W which carried Wafer S in the body 26 of an inner tube and arranging in a predetermined location, it fits into the periphery of the openings 24 and 30 of the body 26 of an inner tube, and the outer-tube body 32, respectively, and the inner-tube covering device 26 and the outer-tube covering device 34 are stopped. Subsequently, the closing motion valves 36, 42, 46, and 50 are opened wide, inert gas (it is [N2 gas and] mainly the following N2 it is called gas) is introduced from the closing motion valves 42 and 46, and the air in the annular space 54 in an inner tube 29 and between an outer tube and an inner tube is discharged from open valves 36 and 50. It is air N2 After gas finishes permuting, open valves 36 and 50 are stopped first, and, subsequently open valves 42 and 46 are stopped. Thereby, the reactor core tube part 12 is N2. After gas has permuted, it is isolated with the

exterior.
[0022] On the other hand, in drawing 1 , the closing motion valve 78 is opened wide, and it is N2. It is gas N2 It is the air in the circulation duct 14 which discharges air from the closing motion valves 68, 70, 72, and 74 opened wide, and includes the interior of the gas heating apparatus 16, fan equipment 18, and the gas cooling machine 20, introducing into the circulation duct 14 from gas installation equipment 22 N2 Gas permutes. The closing motion valves 68, 70, 72, and 74 are stopped after the completion of a permutation, and it is N2. After gas has permuted, equipment 10 is isolated from the exterior.
[0023] Subsequently, the reactor core tube part 12 is connected with the circulation duct 14 in the predetermined connection sections 61, 63, 65, and 67, and each closing motion valves of all are opened. Thereby, the reactor core tube part 12 and the circulation duct 14 are open for free passage, and a thermal treatment equipment 10 will be in the condition that a start up can be carried out. Fan equipment 18 is started, the circulation duct 14 via reactor core tube part 12 is met, and it is N2. It circulates through gas. The need is accepted and it is N2 in the circulation duct 14 by the pressure regulating valve 76. The pressure of gas is adjusted. Then, heating is started with the gas heating apparatus 16. N2 heated the gas excretory system 62 after gas's going into an inner tube 29 from the gas installation system 60 in an inner-tube side, and flow's being disturbed by the baffle 40, flowing the inside of an inner tube 29 in the state of a turbulent flow and heating Wafer S -- a course -- it is again heated with the gas heating apparatus 16, and circulates. At an outer-tube side, it is N2. Gas goes into an outer tube from the gas installation system 64, it heats an inner tube 29, flowing the inside of the annular passage 54, and carries out course circulation of the gas excretory system 66. Thereby, the wafer S in an inner tube 29 is heat-treated.
[0024] N2 which suspends operation of the gas heating apparatus 60, and instead operates and circulates through the gas cooling machine 20 after performing a heat treatment process predetermined time Gas is cooled. Thereby, the wafer in an inner tube is cooled. The reactor core tube part 12 is removed from a thermal treatment equipment 10 after cool down ready, and the wafer boat W which carried Wafer S is picked out from an inner tube 29.
[0025] At this example, since it is taken out from an inner tube 29 after the wafer was carried in in the inner tube 29 in ordinary temperature and having been cooled by ordinary temperature after heat treatment by the above actuation, there is no fear of oxidation with elevated-temperature air which had been produced with conventional equipment. Moreover, N2 which flows the inside of an inner tube 29 in the reactor core tube part 12 N2 which flows the annular passage 54 of the direction of gas, an inner tube, and an outer tube Since the direction of gas is reverse, the temperature distribution of the longitudinal direction of the reactor core tube part 12 are maintainable to homogeneity. Furthermore, it is the outside of an inner tube 29 in which the wafer is held N2 Since gas is flowing, the foreign matter which metal etc. does not have can prevent invading in an inner tube 29 from the exterior, and polluting Wafer S. N2 Since gas is disturbed by the baffle 40 and flows the inside of an inner tube in the state of a turbulent flow, temperature distribution become homogeneity and a wafer can be efficiently heated by the low

flow rate. A procedure is N2 when oxidizing. It applies to gas correspondingly and is O2 from gas installation equipment 22. It is gas from gas installation equipment 23 again H2 Gas is introduced.
[0026] This example shows one embodiment of this invention, replaces it with the double tube type work tube of this example, and the work tube of only an inner tube is sufficient as it, and it does not have the need of not necessarily forming a baffle in the wall surface of an inner tube, either. Moreover, as long as it is not necessary to also make the configuration of a baffle be the same as that of this example and has the function of a baffle, there is no constraint in a configuration.
[0027]
[Effect of the Invention] Since according to invention of claim 1 a wafer is arranged and heat-treated in a thermal treatment equipment and the wafer is already cooled at the time of taking out, being maintained by the inert gas ambient atmosphere isolated from the exterior, there is no possibility of oxidizing by the oxygen under open air like conventional equipment. Moreover, since the time amount which has exposed the wafer to the open air is short, wafer contamination can be controlled. This thermal treatment equipment can be used as annealing equipment, a thermal diffusion furnace, or a thermal oxidation furnace by changing the class of gas to circulate. In invention of claim 2, since the flow direction of the gas which a work tube consists of double pipes, and flows the annular section between the flow direction of the gas in an inner tube, and an inner tube and an outer tube is reverse, the temperature distribution in an inner tube can be made into homogeneity at the time of work tube heating. Moreover, since the outer tube has enclosed the perimeter of an inner tube and the gas is flowing the annular passage between an inner tube and an outer tube, in a heat treatment process, the foreign matter which metal etc. does not have invades in an inner tube from the exterior, and can prevent polluting a wafer. By invention of claim 3, since gaseous flow becomes a turbulent flow and the rate of flow in each location of the cross section of a flow direction is equalized by forming a baffle in the work tube with which the wafer is held, the temperature distribution within a reactor core become fixed by the small flow rate. Therefore, the requirements of inert gas decrease.

[Translation done.]

DESCRIPTION OF DRAWINGS

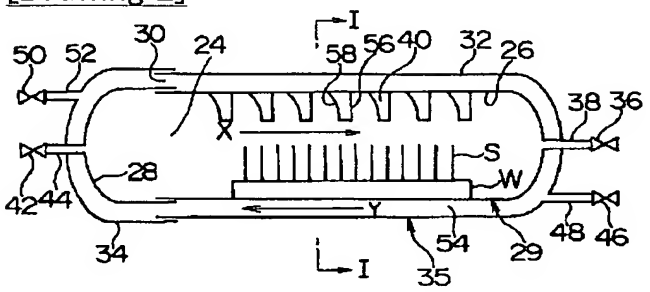
[Brief Description of the Drawings]
[Drawing 1] It is the general flowsheet which shows the configuration of one example of the thermal treatment equipment concerning this invention.
[Drawing 2] It is the typical longitudinal direction sectional view showing the configuration of a work tube.
[Drawing 3] It is the sectional view of view I-I of drawing 2 .
[Drawing 4] Drawing 4 (a) is the sectional view of the longitudinal direction of the baffle tubing 59, and drawing 4 (b) is the cross-sectional view of view II-II of drawing 4 (a).
[Drawing 5] It is the typical sectional view showing the configuration of the conventional thermal treatment equipment.
[Description of Notations]
10 One Example of Thermal Treatment Equipment Concerning this Invention
12 Reactor Core Tube Part
14 Circulation Duct
16 Electric Furnace Type Gas Heating Apparatus
18 Fan Equipment
20 Water Cooling Type Gas Cooling Machine
22 Gas Installation Equipment (N2 Gas and O2 Gas Etc.)
23 Gas Installation Equipment (H2 Gas Etc.)
24 Opening
26 Body of Inner Tube
28 Inner-Tube Covering Device
29 Inner Tube
30 Opening
32 Outer-Tube Body
34 Outer-Tube Covering Device
35 Outer Tube
36, 42, 46, 50 Closing motion valve
38 52 Gas exhaust pipe
40 Baffle
44 48 Gas installation tubing
54 Annular Passage
56 58 Field of a baffle
57 Shell
59 Baffle Tubing
60 64 Gas installation system
61, 63, 65, 67 Connection section
62 66 Gas excretory system
68, 70, 72, 74, 78, 79 Closing motion valve
76 Pressure Regulating Valve

[Translation done.]

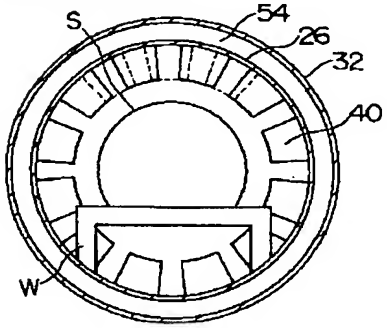
* NOTICES *

DRAWINGS

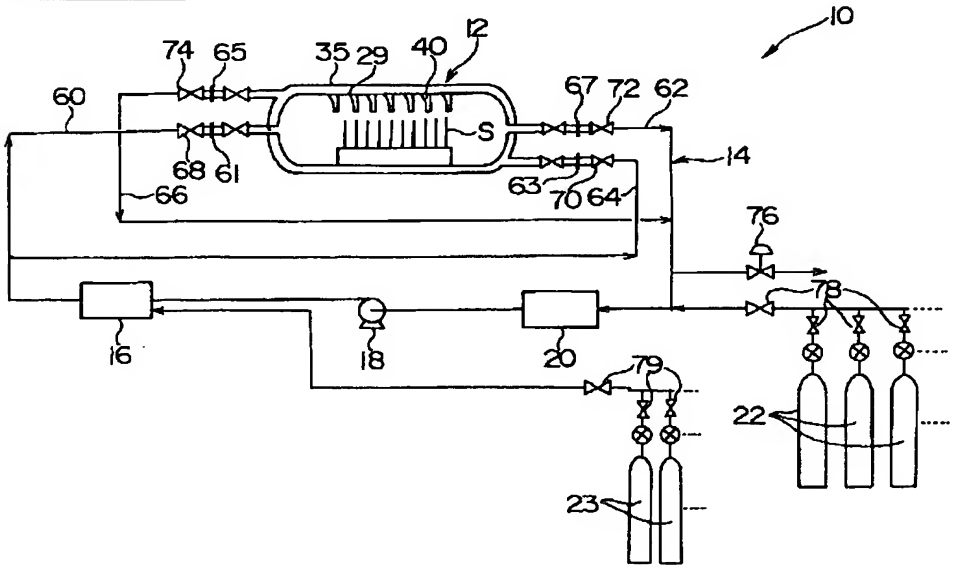
[Drawing 2]



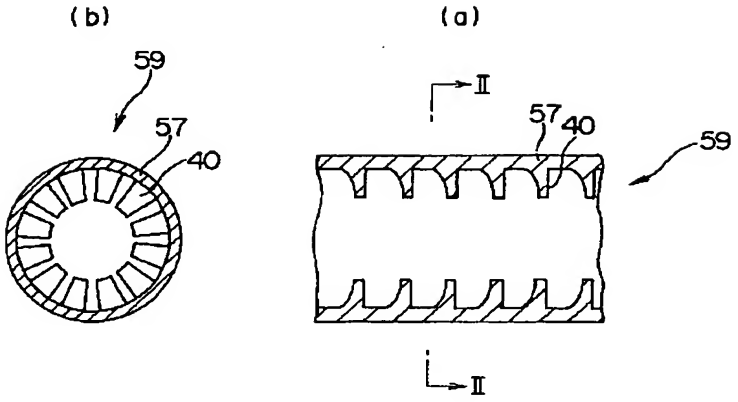
[Drawing 3]



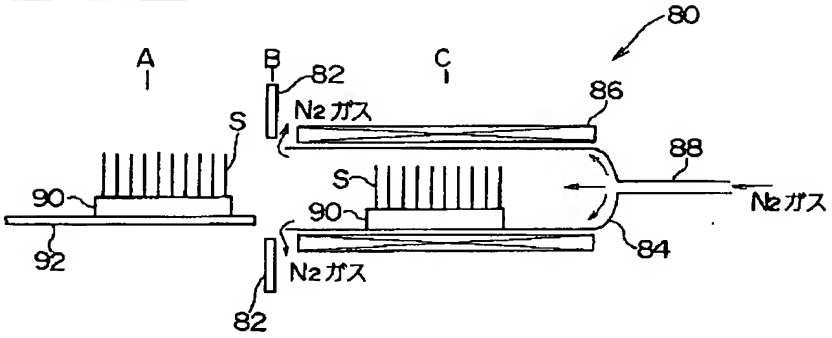
[Drawing 1]



[Drawing 4]



[Drawing 5]



[Translation done.]

[0020] An electric furnace gas heating device 16 is a previously-known gas heating device which has a heating tube inside which a gas flows and has an electric furnace which heats the heating tube. If necessary, a bypass duct is provided around the gas heating device 16, and it is possible to bypass the gas heating device 16 during the below-mentioned cooling process. Moreover, a fan device 18 is a previously-known ventilation fan for high temperature gas which can ventilate high temperature gas. A water-cooled gas cooler 20 is a previously-known water-cooled cooler with double tubes which runs cooling water in the inner tube and which runs gas which cools in the annular space between the inner tube and the outer tube. If necessary, a bypass duct is provided around the gas cooler 20, and it is possible to bypass the gas cooler 20 during the above-mentioned heating process. An N_2 gas introducing device 22 is a device which comprises an N_2 gas cylinder and a gas pressure adjusting valve and which is connected to a circular duct 14 via an opening and closing valve 78.

[0021] A heat treatment method using the device of the present Embodiment shall be explained hereinafter. A furnace core tube section 12 is detached from a heat treatment device 10, and as is shown in Figure 2, a wafer boat W, on which a wafer S is placed, is introduced into an inner tube body 26. After being placed in a predetermined position, an inner tube lid section 26 and an outer tube lid section 34 are fit onto the outer circumferences of aperture sections 24 and 30 of the inner tube body 26 and an outer tube body 32 respectively and the lid sections are then closed. Opening and closing valves 36, 42, 46, and 50 are opened, an inert gas (mainly N_2 gas, hereinafter referred to as N_2 gas) is introduced from opening and closing valves 42 and 46, and air inside an inner tube 29 and inside an annular space 54 between the inner tube and the outer tube is ejected from open valves 36 and 50. After replacing the air with N_2 gas, open valves 36 and 50 are closed, and open valves 42 and 46 are closed. In this manner, the furnace core tube section 12 is isolated from the outside in a state in which the air has been replaced by N_2 gas.

[0022] In Figure 1, the opening and closing valve 78 is opened, and while N_2 gas is being introduced from the N_2 gas introducing device 22 into the circular duct 14, air is ejected from open opening and closing valves 68, 70, 72, and 74, and the air inside the circular duct 14, which includes the inner sections of the gas cooler 20, the fan device 18 and the gas heating device 16, is replaced with N_2 gas. After the replacement is

completed, opening and closing valves 68, 70, 72, and 74 are closed, and the device 10 is isolated from the outside in a state in which the air has been replaced by N_2 gas.

[0023] The furnace core tube section 12 is connected to the circular duct 14 by predetermined connection sections 61, 63, 65, and 67, and all of the opening and closing valves are opened. In this manner, the furnace core tube section 12 is connected to the circular duct 14, and the heat treatment device 10 is in a state in which operation can be started. The fan device 18 is started, and N_2 gas is circulated along the circular duct 14 through the furnace core tube section 12. If necessary, the pressure of the N_2 gas inside the circular duct 14 is adjusted by a pressure adjustment valve 76. Heating is started in the gas heating device 16. With respect to the inner tube, the heated N_2 gas enters the inner tube 29 from a gas introducing system 60, the flow of the N_2 gas is disturbed by interference boards 40, the N_2 gas flows in a turbulent state inside the inner tube 29, and after heating the wafer S, passes through a gas exhaust system 62, is once again heated by the gas heating device 16 and circulated. With respect to the outer tube, the N_2 gas enters the outer tube from a gas introducing system 64, heats the inner tube 29 while flowing inside an annular flow pass 54, and is circulated via a gas exhaust system 66. In this manner, the wafer S inside of the inner tube 29 is heat treated.

[0024] After the heat treatment process has been performed for a predetermined length of time, the operation of gas heating device 60 is stopped, and the gas cooler 20 is operated, cooling the circulating N_2 gas. In this manner, the wafer inside the inner tube is cooled. After the cooling is completed, the furnace core tube section 12 is detached from the heat treatment device 10, and the wafer boat W, on which the wafer S is placed, is retrieved from the inner tube 29.

[0025] In the present Embodiment, by the above operations, the wafer is inserted into the inner tube 29 at a normal temperature, and after heating treatment, is removed from the inner tube 29 in a state in which it has been cooled to normal temperature. Therefore, there is no risk of oxidation by high temperature air such as arises in conventional devices. Moreover, in the furnace core tube section 12, the direction of the N_2 gas which flows inside the inner tube 29 is opposite to the direction of the N_2 gas which flows inside the annular flow pass 54 between the inner tube and the outer tube. Therefore, it is possible to uniformly maintain the temperature distribution in the lengthwise direction of the furnace core tube section 12. Furthermore, because the N_2 gas flows outside of the inner tube 29 which houses the wafer, it is possible to prevent

unwanted foreign substances such as metal from penetrating into the inner tube 29 from outside and contaminating the wafer S. Because the N_2 gas is disturbed by interference boards 40 and flows in a turbulent state inside the inner tube, the temperature distribution is homogenized and it is possible to efficiently heat the wafer with a small flow quantity. In the case of oxidation, instead of N_2 gas, O_2 gas is introduced from the gas introducing device 22 and H_2 gas is introduced from the gas introducing device 23.

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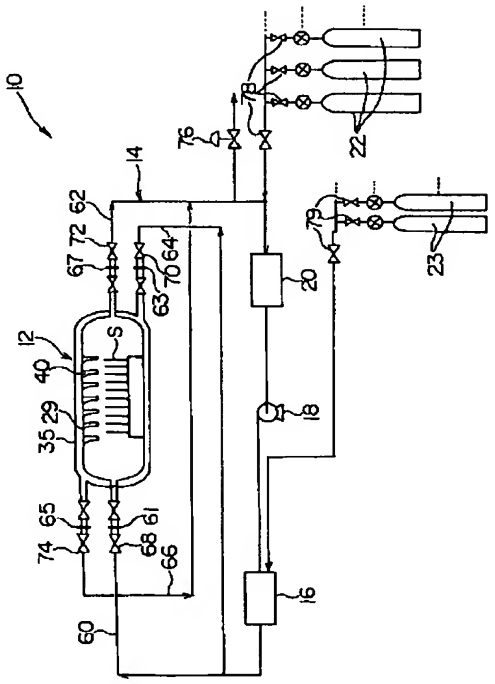
(54)【発明の名称】　熱処理装置

(57)【要約】　（修正有）

【目的】　ウェハ上の酸化膜の形成を防止し、かつ炉心管内を流れる気体の流量を低く抑えつつ炉心管内の温度分布を均一化するようにした熱処理装置を提供する。

【構成】　熱処理装置10は、炉心管部12、循環管路14、電気炉式気体加熱装置、ファン装置18、水冷式気体冷却器20及びガス導入装置22，23とを備えている。炉心管部12は、内管29と外管35からなり、それぞれが開口部を有する本体と開口部に嵌合する蓋部から構成されている。内外管の本体及び蓋部は、それぞれ、開閉弁付き導入管または、排出管を備え、開閉弁を備えた循環路の気体導入系及び気体排出系に連結されている。内管の内壁には、多数の邪魔板40が長手方向及び周方向に離隔して千鳥状に配置されている。ウェハを収容後、不活性ガスに置換し、炉芯管路とを連結し、不活性ガスを循環させる。不活性ガスを加熱し、ウェハを熱処理する。不活性ガスを冷却し、ガスをO_2，H_2に変えて酸化装置にできる。



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【特許請求の範囲】

【請求項１】　開閉自在な開口部を有する炉心管を備え、開口部を介して搬入出した被処理物を炉心管内で熱処理する熱処理装置において、

炉心管に開閉弁付き気体導入口及び開閉弁付き気体排出口とを設け、

更に、炉心管の気体導入口及び気体排出口に解離自在にそれぞれ接続できる、開閉弁付き第１接続口と第２接続口とを備え、かつ炉心管を経由して気体を循環するようにした循環管路と、

循環管路に設けられた気体加熱装置、気体冷却装置及び送風機とを備えることを特徴とする熱処理装置。

【請求項２】　前記炉心管が、被処理物を配置する内管と、内管をその外側から囲む外管とからなる二重管で構成され、それぞれが開閉弁付き気体導入口及び開閉弁付き気体排出口とを有し、かつ内管内を流れる気体の流れ方向と外管と内管との間の環状流路を流れる気体の流れ方向とが逆になるように内管と外管のそれぞれに循環管路が設けられていることを特徴とする請求項１に記載の熱処理装置。

【請求項３】　被処理物を配置する炉心管の管内壁に、炉心管内の気体の流れを乱流状態にする邪魔板を設けたことを特徴とする請求項１又は２に記載の熱処理装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、熱処理装置に関し、更に詳細には、半導体装置用のウェハを加熱して、不純物を熱拡散させたり、又はウェハ上に酸化膜を形成したりするための熱処理装置に関するものである。

【０００２】

【従来の技術】半導体装置の製造工程において、熱処理装置は、ウェハを加熱して、不純物を熱拡散させたり、又はアニーリングを施したり、或いは酸化膜を形成したりするために使用されている。従来の熱処理装置８０は、図５に示すように、Ｂの位置に配置された一方の端部にシャッタ８２付き開口部を有する炉心管８４と、炉心管８４の外周に設けられたヒータ８６とを備えている。N_2 ガスは、炉心管の他方の端部に設けられたN_2 ガス導入口８８から導入され、シャッタ８２の付近の排出口から排出される。

【０００３】ウェハＳを熱拡散処理する時には、ウェハＳをウェハボート９０上に配列して、Ａの位置に待機させる。一方、炉心管８４をヒータ８６で加熱し、所定の温度に到達して段階で、シャッタ８２を開放し、開口部経由ボートローダ９２によりウェハボート９０を炉心管８４内に送入して、所定位置Ｃに配置する。所定時間経過した後、逆の手順でウェハボート９０を炉心管８４から取り出し、Ａの待機位置に戻す。

【０００４】

【発明が解決しようとする課題】しかし、上述した従来の熱処理装置は、次に述べるような問題を有している。先ず、第１の問題は、ウェハの表面に酸化膜が形成されることである。ウェハボートの搬入出時、高温のN_2 ガスが開口部経由炉心管から大気中に大量に放出されるので、外気と高温のN_2 ガスが混ざり合う開口部付近は、高温の酸素が存在する雰囲気となっている。そのため、ウェハボートの搬入出に伴いウェハＳが開口部を通過する時、ウェハは高温の酸素により酸化され、表面に酸化膜が形成される。半導体装置の作製工程では、熱処理工程の後、この酸化膜を除去する工程が実施されるが、除去される前に、酸化膜を構成する酸素によって、不純物が半導体内で異常拡散する現象が生じる。この現象は、半導体装置が微細で高密度である程、半導体装置の特性に影響を与え、半導体装置の品質管理上で問題となっている。

【０００５】第２の問題として、従来の熱処理装置は、炉心管内の温度分布を均一にするために、大量の不活性ガス（主として、N_2 ガス）を炉心管内に流す必要があると言うことである。これは、熱処理工程の費用を増大させる一因になっている。

【０００６】上述の問題に鑑み、本発明の目的は、第１には熱処理工程においてウェハ上に所望でない酸化膜が形成されないように改良された熱処理装置を提供することであり、第２には炉心管内を流れる気体の流量を低く押さえつつ炉心管内の温度分布を均一化するようにした熱処理装置を提供することである。

【０００７】

【課題を解決するための手段】上記した第１の目的を達成するために、本発明に係る熱処理装置は、開閉自在な開口部を有する炉心管を備え、開口部を介して搬入出した被処理物を炉心管内で熱処理する熱処理装置において、炉心管に開閉弁付き気体導入口及び開閉弁付き気体排出口とを設け、更に、炉心管の気体導入口及び気体排出口に解離自在にそれぞれ接続できる、開閉弁付き第１接続口と第２接続口とを備え、かつ炉心管を経由して気体を循環するようにした循環管路と、循環管路に設けられた気体加熱装置、気体冷却装置及び送風機とを備えることを特徴としている。

【０００８】本発明で使用する炉心管は、従来の炉心管と同じ材質、例えば石英製の炉心管で、横型でも縦型でも良い。気体加熱装置は、加熱管内に気体を流し、加熱管を管外から加熱することにより、気体を加熱するようにした既知の手段であって、例えば電気炉内に気体が流れる管路を設けた電気炉形式の気体加熱装置がある。気体冷却装置は、空冷式又は水冷式の既知の気体冷却装置である。また、送風機は、既知の高温ガス用ファンを使用できる。

【０００９】本発明の望ましい実施態様は、炉心管が、被処理物を配置する内管と、内管をその外側から囲む外管とからなる二重管で構成され、それぞれが開閉弁付き

気体導入口及び開閉弁付き気体排出口とを有し、かつ内管内を流れる気体の流れ方向と外管と内管との間の環状流路を流れる気体の流れ方向とが逆になるように内管と外管のそれぞれに循環管路が設けられていることを特徴としている。

【００１０】また、第２の目的を達成するために、本発明に係る望ましい実施態様は、被処理物を配置する炉心管の管内壁に、炉心管内の気体の流れを乱流状態にする邪魔板を設けたことを特徴としている。ここで、邪魔板とは、気体の流れに交差する面を備え、流体力学的に言って気体の流れを乱して乱流状態にする流れの障害物であって、気体流れ方向に直交する流路の断面の各位置において気体の流速を均一にする機能を有する。邪魔板の形状は、その目的を果たす限り特に制約はない。

【００１１】

【作用】請求項１の発明では、ウェハを載せたウェハボートを内部に収容し、不活性ガスにて空気を置換し、かつ外部から隔離された炉心管と、同様に不活性ガスにて空気を置換し、かつ外部から隔離された循環管路とを連結し、循環管路に沿って炉心管経由送風機により不活性ガスを循環させる。次いで、循環する不活性ガスを気体加熱装置により加熱し、高温の不活性ガスで炉心管内のウェハを熱処理する。熱処理工程の終了後、気体加熱装置を停止し、循環する不活性ガスを気体冷却装置により冷却する。冷却終了後、炉心管を循環管路から分離し、更に開口部を開放して冷却されたウェハボートを取り出す。炉心管内部を不活性ガスにて置換し、外気から隔離するには、気体導入口から不活性ガスを導入し、気体排出口から不活性ガスを排出しつつ、気体導入口及び気体排出口の開閉弁を閉止する。同様に、循環管路内部を不活性ガスで置換し、外気から隔離するには、循環管路及び循環管路に接続された気体加熱装置、気体冷却装置及び送風機のそれぞれの気体流路に不活性ガスを導入、排出しつつ、第１接続口及び第２接続口の開閉弁を閉止する。

【００１２】請求項２の発明では、炉心管が二重管で構成され、かつ内管内の気体の流れ方向と、内管と外管との間の環状部を流れる気体の流れ方向が逆であるから、炉心管加熱時、内管内の温度分布を均一にすることができる。また、内管の周囲を外管が囲っているので、メタル等の好ましくない異物が外部から内管内に侵入する恐れがない。

【００１３】請求項３の発明では、ウェハが収容されている炉心管に邪魔板を設けることにより、気体の流れが乱流になって流れ方向の断面の各位置での流速が均一化されるので、少ない流量で炉心管内の温度分布が一定になる。

【００１４】

【実施例】以下、添付図面を参照し、実施例に基づいて本発明をより詳細に説明する。図１は本発明に係る熱処理装置の一実施例の構成を示す概略フローシート、図２は炉心管の構成を示す模式的断面図、図３は図２の矢視Ｉ－Ｉの断面図である。本実施例の熱処理装置１０は、図１に示すように、炉心管部１２、循環管路１４、電気炉式気体加熱装置１６、ファン装置１８、水冷式気体冷却器２０、N_2及びO_2 ガスなどのガス導入装置２２及びH_2 ガスなどのガス導入装置２３とを備えている。

【００１５】炉心管部１２は、図２に示すように、一方の端部に開口部２４を有する内管本体２６と、開口部２４の外周に嵌合して開口部２４を閉止する内管蓋部２８とからなる内管２９と、内管本体２６の外周を取り囲み、内管本体２６と同じ側の端部に開口部３０を有する外管本体３２と、外管本体３２の開口部３０の外周に嵌合して開口部３０を閉止する外管蓋部３４とからなる外管３５とから構成されている。

【００１６】内管本体２６の開口部２４と反対側の端部及び内管蓋部３４には、それぞれ開閉弁３６を有する気体排出管３８及び開閉弁４２を有する気体導入管４４が設けられており、内管２９内を矢印の方向Ｘに気体が流れる。また、外管本体３２の開口部３０と反対側の端部及び外管蓋部３４には、それぞれ開閉弁４６を有する気体導入管４８及び開閉弁５０を有する気体排出管５２が設けられている。内管本体２６の気体排出管３６及び内管蓋部２６の気体導入管４４は、それぞれ外管本体３２の端部壁及び外管蓋部３４を貫通して外方に突出している。その貫通部は、管が端部壁又は蓋部壁と一体的に接合されていても良く、また端部壁又は蓋部の貫通孔に管を貫通させた後、封止剤で封止しても良い。以上の構成により、内管２９と外管３５との間には環状の気体流路５４が形成され、気体は、環状流路５４内を矢印Ｙの方向に流れる。

【００１７】内管本体２６の内壁面には、多数個の邪魔板４０が全面にわたり設けてある。邪魔板４０は、図２に示すように、内管本体２６の長手方向に見て略台形の断面形状を有するブロックであって、図３に示すように、内管本体２６の内壁の全面にわたり、内管本体２６の周方向及び長手方向に離隔して、しかも長手方向に見て千鳥状に配列されている（図３の破線は、実線で表示した邪魔板４０の後方に千鳥状に配置されたものの例示である）。各邪魔板４０は、図２に示すように、気体の流れの下流側の面５６が内管本体２６の長手方向に直交する平面を成し、上流側の面５８が、内管本体２６の壁面に向かうに従い下流側の面５６から離隔するような曲面を成し、内管本体２６の壁面から高さは、ウェハボート上に載置されたウェハに衝突しないような寸法になっている。

【００１８】邪魔板４０は、内管本体２６と一体的に形成してもよく、また図４（ａ）及び（ｂ）に示すように、内管本体２６の内径にほぼ等しい外径の管体５７に邪魔板４０のブロックを設けた邪魔板管５９を別途形成

し、必要に応じてそれを内管本体２６内に挿入し、不要になれば引き出すようにしても良い。図４（ａ）は邪魔板管５９の長手方向の断面図、図４（ｂ）は図４（ａ）の矢視II－IIの横断面図である。

【００１９】循環管路１４は、図１に示すように、内管２９に接続される気体導入系６０及び気体排出系６２の内管系と、外管３５に接続される気体導入系６４及び気体排出系６６の外管系の２系統から構成されている。気体導入系６０、６４及び気体排出系６２、６６は、連結部６１、６３、６５、６７により炉心管部１２の各気体導入管及び気体排出管に連結され、かつ連結部付近にそれぞれ開閉弁６８、７０、７２及び７４を備えている。連結部６１、６３、６５、６７の連結方式は、いわゆるクィック・カップリング式又は嵌合式であって、簡便かつ素早く連結できるようになっている。更に、循環管路内のN_2 ガスの圧力を調整するために、圧力調整弁７６が循環管路１４に設けてある。

【００２０】電気炉式気体加熱装置１６は、気体が内部を流れる加熱管と加熱管を加熱する電気炉とからなる既知の気体加熱装置である。必要に応じて、バイパス管路を気体加熱装置１６の周りに設け、後述する冷却工程の際には気体加熱装置１６をバイパスさせてもよい。また、ファン装置１８は、高温ガスを送風できる高温ガス用の既知の送風ファンである。水冷式気体冷却器２０は、既知の二重管型の水冷式冷却器であって、内管に冷却水を流し、内管と外管との環状空間に冷却する気体を流すようになっている。必要に応じて、バイパス管路を気体冷却器２０の周りに設け、前述した加熱工程の際には気体冷却器２０をバイパスさせてもよい。N_2 ガス導入装置２２は、N_2 ガスボンベとガス圧力調整弁とを備えた装置で、開閉弁７８を介して循環管路１４に接続されている。

【００２１】以下に、本実施例装置を使用して、熱処理する方法を説明する。先ず、熱処理装置１０から炉心管部１２を取り外し、図２に示すように、ウェハＳを載せたウェハボートＷを内管本体２６内に導入し、所定位置に配置した後、内管蓋部２６及び外管蓋部３４をそれぞれ内管本体２６及び外管本体３２の開口部２４、３０の外周に嵌合して閉止する。次いで、開閉弁３６、４２、４６及び５０を開放し、開閉弁４２及び４６から不活性ガス（主にN_2 ガス、以下N_2 ガスという）を導入し、開放弁３６及び５０から内管２９内及び外管と内管との間の環状空間５４内の空気を排出する。空気をN_2 ガスで置換し終わった後、まず開放弁３６及び５０を閉止し、次いで開放弁４２及び４６を閉止する。これにより、炉心管部１２は、N_2 ガスで置換された状態で外部とは隔離される。

【００２２】一方、図１において、開閉弁７８を開放し、N_2 ガスをN_2 ガス導入装置２２から循環管路１４に導入しつつ、開放した開閉弁６８、７０、７２及び７４から空気を排出し、気体加熱装置１６、ファン装置１８及び気体冷却器２０の内部を含む循環管路１４内の空気をN_2 ガスで置換する。置換完了後、開閉弁６８、７０、７２及び７４を閉止し、N_2 ガスで置換された状態で装置１０を外部から隔離する。

【００２３】次いで、炉心管部１２を循環管路１４に所定の連結部６１、６３、６５、６７で連結し、各開閉弁を全て開放する。これにより、炉心管部１２と循環管路１４とは連通し、熱処理装置１０は運転開始できる状態になる。ファン装置１８を起動し、炉心管部１２経由循環管路１４に沿ってN_2 ガスを循環する。必要に応じ、圧力調整弁７６によって循環管路１４内のN_2 ガスの圧力を調整する。続いて、気体加熱装置１６で加熱を開始する。加熱されたN_2 ガスは、内管側では気体導入系６０から内管２９に入り、邪魔板４０により流れが乱されて乱流状態で内管２９内を流れ、ウェハＳを加熱した後、気体排出系６２を経由、再び気体加熱装置１６で加熱されて循環する。外管側では、N_2 ガスは、気体導入系６４から外管に入り、環状流路５４内を流れつつ内管２９を加熱し、気体排出系６６を経由循環する。これにより、内管２９内のウェハＳは、熱処理される。

【００２４】熱処理工程を所定時間行った後、気体加熱装置６０の運転を停止し、代わって、気体冷却器２０を運転し、循環するN_2 ガスを冷却する。これにより、内管内のウェハは、冷却される。冷却完了後、炉心管部１２を熱処理装置１０から取り外し、内管２９からウェハＳを載せたウェハボートＷを取り出す。

【００２５】本実施例では、以上の操作により、ウェハは、常温で内管２９内に搬入され、また熱処理後、常温に冷却された状態で内管２９から搬出されるので、従来の装置で生じていたような、高温空気による酸化の恐れは無い。また、炉心管部１２では、内管２９内を流れるN_2 ガスの方向と内管と外管との環状流路５４を流れるN_2 ガスの方向とが逆になっているので、炉心管部１２の長手方向の温度分布を均一に維持することができる。更には、ウェハが収容されている内管２９の外側をN_2 ガスが流れているので、メタル等の望ましくない異物が外部から内管２９内に侵入してウェハＳを汚染するのを防止することができる。N_2 ガスは邪魔板４０により撹乱されて乱流状態で内管内を流れるので、温度分布が均一になり、低い流量で効率良くウェハを加熱することができる。酸化する場合には、手順はN_2 ガスに準じて、ガス導入装置２２からO_2 ガスを、またガス導入装置２３からH_2 ガスを導入する。

【００２６】本実施例は、本発明の一つの実施態様を示すものであって、本実施例の二重管式炉心管に代えて、内管のみの炉心管でもよく、また必ずしも邪魔板を内管の壁面に設ける必要も無い。また、邪魔板の形状も本実施例と同様にする必要はなく、邪魔板の機能を有する限り、特に形状に制約はない。

【００２７】

【発明の効果】請求項１の発明によれば、外部から隔離された不活性ガス雰囲気に維持されつつウェハは熱処理装置内に配置されて熱処理され、また搬出時、ウェハは既に冷却されているので、従来の装置のように外気中の酸素により酸化される恐れはない。また、外気にウェハを露出している時間が短いので、ウェハ汚染を抑制することができる。本熱処理装置は、循環させる気体の種類を変えることにより、アニーリング装置、熱拡散装置又は熱酸化装置として使用することができる。請求項２の発明では、炉心管が二重管で構成され、かつ内管内の気体の流れ方向と、内管と外管との間の環状部を流れる気体の流れ方向が逆であるから、炉心管加熱時、内管内の温度分布を均一にすることができる。また、内管の周囲を外管が囲っていて、かつ気体が内管と外管との間の環状流路を流れているので、熱処理工程において、メタル等の好ましくない異物が外部から内管内に侵入し、ウェハを汚染するのを防止できる。請求項３の発明では、ウェハが収容されている炉心管に邪魔板を設けることにより、気体の流れが乱流になって流れ方向の断面の各位置での流速が均一化されるので、少ない流量で炉心管内の温度分布が一定になる。よって、不活性ガスの所要量が低減する。

【図面の簡単な説明】

【図１】本発明に係る熱処理装置の一実施例の構成を示す概略フローシートである。

【図２】炉心管の構成を示す模式的長手方向断面図である。

【図３】図２の矢視Ｉ－Ｉの断面図である。

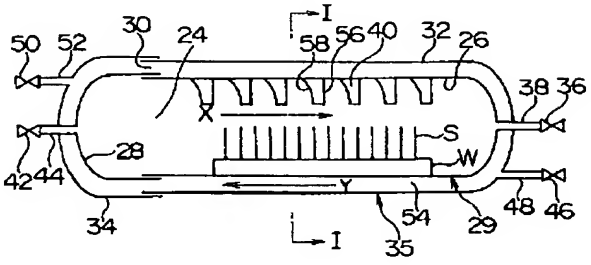
【図４】図４（ａ）は邪魔板管５９の長手方向の断面図、図４（ｂ）は図4（ａ）の矢視II－IIの横断面図である。

【図５】従来の熱処理装置の構成を示す模式的断面図である。

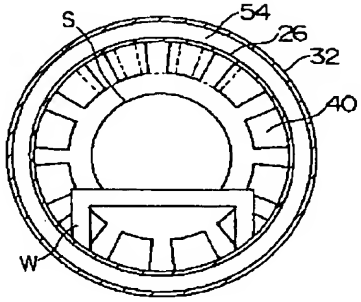
【符号の説明】

１０　本発明に係る熱処理装置の一実施例
１２　炉心管部
１４　循環管路
１６　電気炉式気体加熱装置
１８　ファン装置
２０　水冷式気体冷却器
２２　ガス導入装置（N_2 ガス、O_2 ガスなど）
２３　ガス導入装置（H_2 ガスなど）
２４　開口部
２６　内管本体
２８　内管蓋部
２９　内管
３０　開口部
３２　外管本体
３４　外管蓋部
３５　外管
３６、４２、４６、５０　開閉弁
３８、５２　気体排出管
４０　邪魔板
４４、４８　気体導入管
５４　環状流路
５６、５８　邪魔板の面
５７　管体
５９　邪魔板管
６０、６４　気体導入系
６１、６３、６５、６７　連結部
６２、６６　気体排出系
６８、７０、７２、７４、７８、７９　開閉弁
７６　圧力調整弁

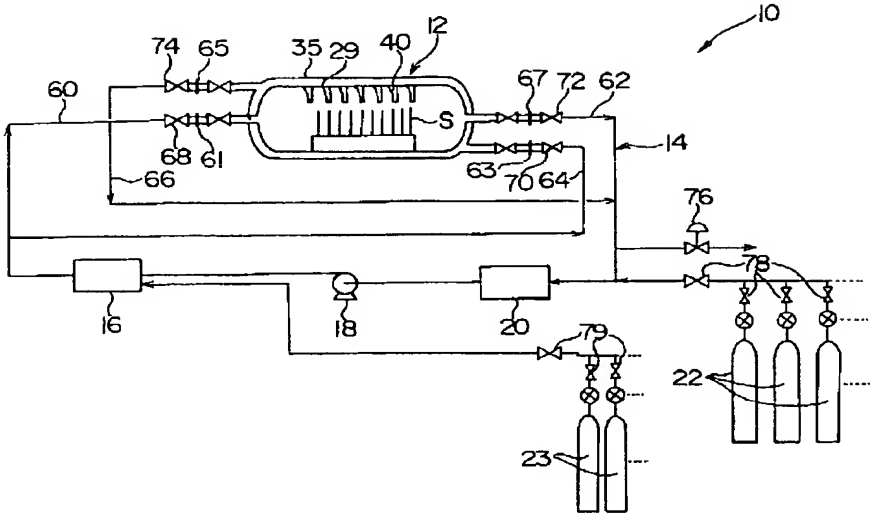
【図２】



【図３】



【図１】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72
62
60
S
68
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14
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63
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64
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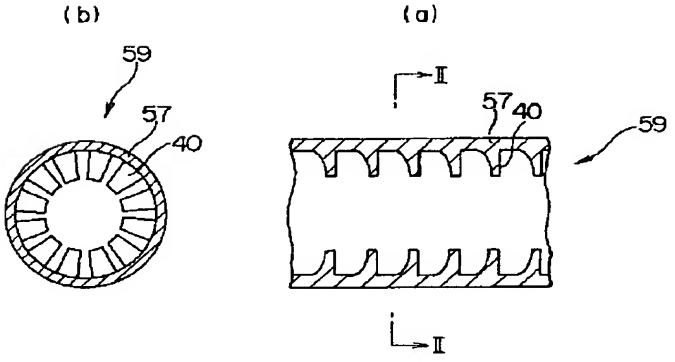
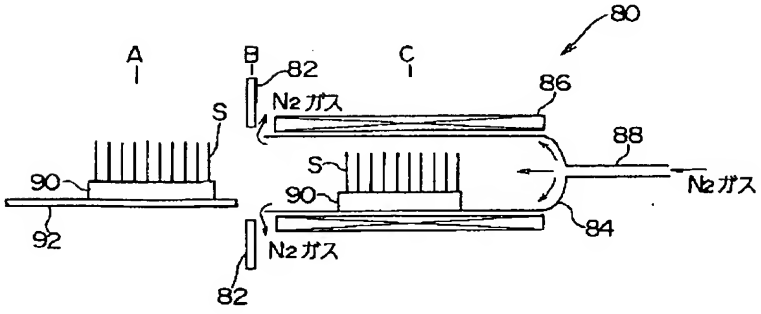
【図４】


(b)
(a)
59
57
40
Ⅱ
57
40
59
Ⅱ

【図５】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A
B
C
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N2ガス
86
S
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S
90
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N2ガス
92
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N2ガス
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